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Douglas-fir Beetle Brood Densities and Infestation Trends on a New Mexico Study Area

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The density of callow adult beetles before flight is a good indicator of the trend an infestation will take. It should be possible to devise a systematic sampling system to determine adult numbers that would enable the entomologist to predict infestation trends quite accurately.

During the past 10 years, the Douglas-fir beetle, Dendroctonus pseudotsugae Hopkins, has killed many thousands of Douglar-fir trees, Pseudotsuga menziesii (Mirb.) Franco, in Arizona and New Mexico. Some of the outbreaks have been so severe that timber management plans were adversely affected (fig. 1). A study was started in 1959 to determine the relationship between preemergence brood density in standing infested trees and the number of trees attacked during subsequent flight as a possible basis for predicting the course of outbreaks. The study was made in a 2-year-old infestation on the Sante Fe National Forest in north-central New Mexico. The study area lay on a north slope between 7,800 and 9,200 feet elevation, and included about 2,500 acres of heavily stocked virgin mixed conifer forest. The brood density and number of trees killed in the area were determined each year until the outbreak collapsed in 1965.

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Methods

Brood densities were sampled in May in 25 infested trees selected from 6 to 10 groups scattered throughout the study area. Six-inch-square bark sections were taken from both the north and south sides of each sample tree at heights of 5 and 10 feet (fig. 2). Numbers of living and dead bark beetles were recorded by life stage. Diameter at breast height, attacks (entrance holes), inches of egg gallery, and parasite numbers were recorded for each sample tree to help interpret the brood density data.

The study area was aerially surveyed each June or July to determine annual increase or decrease in tree kill. The surveys were made by two observers flying at 400 to 600 feet above the forest canopy.

Figure 1.--A severe Douglas-fir beetle infestation such as this can disrupt timber management plans.

Figure 2.--Method of sampling trees at the 10-foot level.

Results

Diameters of Sampled Trees

Diameters of the 142 trees sampled ranged between 10 and 29 inches at breast height. The 25-tree means ranged between 16.0 and 19.2 inches. Diameter of the sampled trees was not significantly correlated with attack density, egg gallery density, or brood density at the heights sampled.

Brood density

Brood density was high in 1959 and 1960, but declined thereafter (table 1). The high proportion of larvae to callow adults in 1961 and 1962 suggests that the downward trend of infestation in these years was associated with slow brood development. Furniss[2] found that a long-term infestation of D. pseudotsugae in southern Utah subsided because of slow brood development. Apparently the beetles which were larvae in late May failed to emerge in June at the time of the main flight. Only live adults were used, therefore, to associate preflight beetle densities with subsequent tree killing.

Live adult density varied greatly between trees during any one year. The variance was greater than the mean number of live adults in all but the 1960 and 1961 samples collected at 10 feet. Variance between trees was generally greater at 5 feet than at 10 feet. The differences in mean live adult densities between heights were significant in 1960, 1962, and 1964. This finding points out the importance of sampling at consistent heights above the ground.

[2] *Furniss, M. M. An instance of delayed emergence of the Douglas-fir beetle and its effect on an infestation in southern Utah. J. Econ. Entomol. 58: 440-442. 1965.*

Table 1.--Mean number of living Douglas-fir beetles per square foot of bark at 5 and 10 feet above the ground, Holy Ghost Canyon, Santa Fe National Forest, New Mexico

Year sampled	Larvae		Adults		Trees attacked upon emergence
	5 feet aboveground	10 feet aboveground	5 feet aboveground	10 feet aboveground	
	Number				
1958	--	--	--	--	[1]150
1959	--	0	--	39.5	205
1960	1.6	1.1	29.8 ± 7.6	60.4 ± 7.6	311
1961	2.6	6.4	12.8 ± 4.4	24.7 ± 3.0	129
1962	4.9	11.1	.6 ± .1	7.7 ± 2.8	27
[2]1963	.5	.6	13.8 ± 4.3	29.9 ± 8.0	36
1964	3.4	2.8	14.2 ± 4.5	17.6 ± 5.0	18

[1]Based on ground observations.
[2]Based on 17 sampled trees.

Despite the variation between trees, the mean number of live adults just prior to flight appears to be correlated with the number of trees attacked during the flight and subsequently killed. Table 1 shows that tree killing increased from the previous year when preemergence adult numbers at 10 feet were greater than 30 per square foot, but decreased when the average number was less than 25. Adult densities at 5 feet were not as well correlated with changes in the number of trees attacked and killed.

Attack, Egg Gallery, and Parasite Densities

The means for both inches of egg gallery and average number of attacks were consistently higher (significantly so in many cases) and their variances lower at 10 feet than at 5 feet (table 2). Numbers of entomophagous insects (mainly Coelodes brunneri Vier.) were extremely variable at both heights, but were consistently higher at 10 feet above the ground. On the basis of these data, neither attack density, inches of egg gallery, nor parasite densities appears to be an indicator of infestation trend.

Table 2.--Mean numbers of Douglas-fir beetle attacks, inches of egg gallery, and entomophagous insects per square foot of bark at 5 and 10 feet above the ground, Holy Ghost Canyon, Santa Fe National Forest, New Mexico

Year sampled	Attacks		Egg gallery		Entomophagous insects	
	5 feet aboveground	10 feet aboveground	5 feet aboveground	10 feet aboveground	5 feet aboveground	10 feet aboveground
	Number		Inches		Number	
1959	--	--	--	--	--	--
1960	7.5	7.7	34	42	0.8	5.6
1961	6.6	11.4	39	51	2.4	8.4
1962	5.8	7.5	20	38	0.3	6.2
1963	6.5	7.6	24	39	2.0	5.2
1964	5.8	6.7	28	40	2.2	2.7